

What is claimed is:

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1        1. A reinforced composite ionic conductive polymer membrane  
2           comprising:  
3              a porous support;  
4              an ion-exchange polymer that impregnates the porous support; and  
5              a reinforcing agent that impregnates the porous support, the reinforcing agent  
6           being at least one selected from the group consisting of a moisture retentive material  
7           and a catalyst for facilitating oxidation of hydrogen.

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1        2. The reinforced composite ionic conductive polymer membrane as  
2           claimed in claim 1, wherein the moisture retentive material comprises at least one  
3           selected from the group consisting of  $\text{SiO}_2$ ,  $\text{TiO}_2$ ,  $\text{ZrO}_2$ , mordenite, tin oxide, and  
4           zeolite.

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1        3. The reinforced composite ionic conductive polymer membrane as  
2           claimed in claim 1, wherein the catalyst comprises at least one selected from the  
3           group consisting platinum (Pt), palladium (Pd), ruthenium (Ru) rhodium (Rh), iridium  
4           (Ir), gold (Au), and a Pt/Ru alloy.

1           4. The reinforced composite ionic conductive polymer membrane as  
2       claimed in claim 1, wherein the reinforcing agent comprises about 3-90% by weight  
3       of the moisture retentive material and about 10-97% by weight of the catalyst, based  
4       on the total weight of the reinforcing agent.

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1           5. The reinforced composite ionic conductive polymer membrane as  
2       claimed in claim 1, wherein the ion-exchange polymer includes at least one selected  
3       from the group consisting of a sulfonic acid group, a carboxyl group, a phosphoric  
4       acid group and a perchloric acid group as a reactive site and has an equivalent  
5       weight of about 600-1200 g/H<sup>+</sup>.

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1           6. The reinforced composite ionic conductive polymer membrane as  
2       claimed in claim 1, wherein the porous support comprises at least one polymer  
3       membrane that has at least about 30% porosity.

1           7. The reinforced composite ionic conductive polymer membrane as  
2       claimed in claim 1, wherein the porous support comprises at least one polymer  
3       membrane that is selected from the group consisting of polytetrafluoroethylene,  
4       vinylidene fluoride-hexafluoropropylene copolymer, polypropylene, polyethylene, and  
5       polysulfone.

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1           8. The reinforced composite ionic conductive polymer membrane as  
2 claimed in claim 1, wherein at least one functional group selected from the group  
3 consisting of a carboxyl group, a sulfonic acid group, a phosphoric acid group, and a  
4 perchloric acid group is incorporated into the polymer membrane.

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2           9. The reinforced composite ionic conductive polymer membrane as  
3 claimed in claim 1 which is formed by impregnating or spray-coating the porous  
4 support with a composition of the ion-exchange polymer and the reinforcing agent.

1           10. A fuel cell comprising a reinforced composite ionic conductive polymer  
2 membrane, the membrane comprising:

3           a porous support;

4           an ion-exchange polymer that impregnates the porous support; and

5           a reinforcing agent that impregnates the porous support, the reinforcing agent  
6 being at least one selected from the group consisting of a moisture retentive material  
7 and a catalyst for facilitating oxidation of hydrogen.

1           11. The fuel cell as claimed in claim 10, wherein the moisture retentive  
2 material comprises at least one selected from the group consisting of  $\text{SiO}_2$ ,  $\text{TiO}_2$ ,  
3  $\text{ZrO}_2$ , mordenite, tin oxide, and zeolite.

1       12. The fuel cell as claimed in claim 10, wherein the catalyst comprises at  
2 least one selected from the group consisting platinum (Pt), palladium (Pd), ruthenium  
3 (Ru) rhodium (Rh), iridium (Ir), gold (Au), and a Pt/Ru alloy.

1       13. The fuel cell as claimed in claim 10, wherein the reinforcing agent  
2 comprises about 3-90% by weight of the moisture retentive material and about  
3 10-97% by weight of the catalyst, based on the total weight of the reinforcing agent.

1       14. The fuel cell as claimed in claim 10, wherein the ion-exchange polymer  
2 includes at least one selected from the group consisting of a sulfonic acid group, a  
3 carboxyl group, a phosphoric acid group, and a perchloric acid group as a reactive  
4 site and has an equivalent weight of about 600-1200 g/H<sup>+</sup>.

1       15. The fuel cell as claimed in claim 10, wherein the porous support  
2 comprises at least one polymer membrane that has at least about 30% porosity.

1       16. The fuel cell as claimed in claim 10, wherein the porous support  
2 comprises at least one polymer membrane selected from the group consisting of  
3 polytetrafluoroethylene, vinylidene fluoride-hexafluoropropylene copolymer,  
4 polypropylene, polyethylene, and polysulfone.

1           17. The fuel cell as claimed in claim 10, wherein at least one functional  
2         group selected from the group consisting of a carboxyl group, a sulfonic acid group,  
3         a phosphoric acid group, and a perchloric acid group is incorporated into the polymer  
4         membrane.

18. The fuel cell as claimed in claim 10, wherein the reinforced composite  
ionic conductive polymer membrane is formed by impregnating or spray-coating the  
porous support with a composition of the ion-exchange polymer and the reinforcing  
agent.

- 1        19. A direct methanol fuel cell comprising a reinforced composite ionic
- 2              conductive polymer membrane, the membrane comprising:
  - 3                  a porous support;
  - 4                  an ion-exchange polymer that impregnates the porous support; and
  - 5                  a reinforcing agent that impregnates the porous support, the reinforcing agent
  - 6                  being at least one selected from the group consisting of a moisture retentive material
  - 7                  and a catalyst for facilitating oxidation of hydrogen.

1        20. The direct methanol fuel cell as claimed in claim 19, wherein the  
2 porous support comprises at least one polymer membrane that has a porosity of at  
3 least about 30% and a proton exchange functional group.

1        21. The direct methanol fuel cell as claimed in claim 19, wherein the  
2 porous support comprises at least one polymer membrane selected from the group  
3 consisting of polytetrafluoroethylene, vinylidene fluoride-hexafluoropropylene  
4 copolymer, polypropylene, polyethylene, and polysulfone.

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1        22. The direct methanol fuel cell as claimed in claim 20, wherein the proton  
2 exchange functional group is at least one selected from the group consisting of a  
3 carboxyl group, a sulfonic acid group, a phosphoric acid group, and a perchloric acid  
4 group.

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1        23. A method of forming a reinforced composite ionic conductive polymer  
2 membrane, the method comprising the steps of:  
3              providing a porous support;  
4              forming a mixture of an ion-exchange polymer and a reinforcing agent, the  
5 reinforcing agent being at least one selected from the group consisting of a moisture  
6 retentive material and a catalyst for facilitating oxidation of hydrogen, and  
7              impregnating the porous support with the mixture.